THE EFFECT OF ULTRASOUND VERSUS NERVE AND TENDON GLIDING EXERCISE ON PAIN AND FUNCTIONS IN PATIENTS WITH CARPAL TUNNEL SYNDROME

-A COMPARATIVE STUDY

Dissertation submitted to The Tamil Nadu Dr. M.G.R. Medical University towards partial fulfillment of the requirements of **MASTER OF PHYSIOTHERAPY (Advanced PT in ORTHOPEDICS) DEGREE PROGRAMME.**

KMCH COLLEGE OF PHYSIOTHERAPY

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CERTIFICATE

This is to certify that the research work entitled "**THE EFFECT OF ULTRASOUND VERSUS NERVE AND TENDON GLIDING EXERCISE ON PAIN AND FUNCTIONS IN PATIENTS WITH CARPAL TUNNEL SYNDROME"** was carried out by the candidate bearing the **Register No: 27111102,** KMCH College of Physiotherapy**,** towards partial fulfillment of the requirements of the **Master of Physiotherapy (Advanced PT in orthopedics)** of The Tamilnadu Dr. M.G.R. Medical University, Chennai-32.

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ABSTRACT

OBJECTIVES:

To compare the effect of ultrasound versus nerve and tendon gliding exercise on pain and functions in patients with Carpal Tunnel Syndrome(CTS).

STUDY DESIGN:

Quasi experimental study design .

STUDY SETTING:

Department of physiotherapy, Kovai Medical Centre and Hospital, Coimbatore.

SAMPLE SIZE:

20 Patients with Carpal tunnel syndrome who met the inclusion criteria were selected for the study.

- GROUP- A: 10 Patients
- GROUP- B: 10 Patients

INTERVENTION:

- Group A received ultrasound treatment.
- Group B received nerve and tendon gliding exercise.

OUTCOME MEASURE:

- Visual Analogue Scale(VAS)
- The Disabilities of Arm, Shoulder and Hand score (DASH)

MEASUREMENT TOOL:

- Hand held dynamometer

RESULTS:

Statistical analysis was done using the‘t’ test, which showed a significant improvement in visual analogue scale and the disabilities of arm shoulder and hand score for ultrasound group than the nerve and tendon gliding exercises group. Power grip strength was assessed using the hand held dynamometer showed no statistical significant difference between both the groups.

CONCLUSION:

According to the results, it is concluded that ultrasound treatment is effective in improving pain; self- reported symptom severity and strength of power grip than nerve and tendon gliding exercise.

KEYWORDS:

- Carpal tunnel syndrome
- Nerve and tendon gliding
- Ultra sound
- DASH
- VAS
- Hand held dynamometer

1. INTRODUCTION

Carpal Tunnel Syndrome (CTS) is a collection of characteristic symptoms and signs that occurs following entrapment of the median nerve within the carpal tunnel[31.] Usual symptoms include numbness, paraesthesia, and pain in the median nerve distribution. These symptoms may or may not be accompanied by objective changes in sensation and strength of median-innervated structures in the hand[37, 14.] Symptoms are worst at night and often wake the patient[3.]

The prevalence of carpal tunnel syndrome in general population is 2.7%.[2, 7]Most cases of Carpal tunnel syndrome are of unknown causes or idiopathic. Carpal tunnel syndrome can be associated with any condition that causes pressure on the median nerve at the wrist. Some common conditions that can lead to carpal tunnel syndrome include thyroid disease, diabetes mellitus, arthritis, obesity, alcoholism, pregnancy. Other causes of this condition include intrinsic factors that exert pressure within the tunnel, and extrinsic factors (pressure exerted from outside the tunnel), which include benign tumours such as lipomas,ganglion and vascular malformation[41.]

The pathophysiology is not completely understood but can be considered compression of the median nerve travelling through the carpal tunnel resulting in ischemia or mechanical injury which impaired nerve conduction velocity[43.]Compression of the median nerve as it runs deep to the transverse carpal ligament (TCL) causes atrophy of the thenar eminence, weakness of the flexor pollicis brevis, opponens pollicis, abductor pollicis brevis, as well as sensory loss or numbness of the thumb, index, long and radial half of the ring finger supplied by the median nerve.

The only scientifically established disease modifying treatment is surgery to cut the transverse carpal ligament.

A non-surgical treatment should be given to patients with mild to moderate carpal tunnel syndrome. Conservative treatment options include splints, activity modification, and

local injection of corticosteroids, non-steroidal anti- inflammatory drugs, diuretics, and pyridoxine. In addition, yoga, chiropractics, ultrasound and laser treatment have been advocated[3, 13.] Ultrasound treatments have the potential to induce various biophysical effects within tissue.

Ultrasound treatment resulting in increase in blood flow, local metabolism, tissue regeneration and also reducing pain,oedema and inflammation[3.] But there is limited evidence regarding the effectiveness of ultrasound on carpal tunnel syndrome[13.]

Recently several studies had shown that nerve and tendon gliding exercise as a traditionally advocated treatment modality in conservative management of carpal tunnel syndrome[29, 8.]These exercises will result in direct mobilisation of nerve; increase venous return, decrease of oedema, pressure in perineum and carpal tunnel pressure[8, 9, 40, 36.] These exercises are frequently used but only a few research performed to support the use of this exercises[26.]

1.1 NEED FOR THE STUDY

The prevalence of Carpal tunnel syndrome has been increasing recently. Mild to moderate carpal tunnel syndrome is usually treated by conservative management.

Ultrasound is used as conservative treatment in carpal tunnel syndrome. Nerve and tendon gliding exercise is also used in some studies as a conservative management in carpal tunnel syndrome. But there was no study which compares the effectiveness of ultrasound versus nerve and tendon gliding exercise.

So this study is done to compare the effect of ultrasound versus nerve and tendon gliding exercises on pain, self- reported symptom severity and strength of power grip in patients with Carpal tunnel syndrome.

1.2 AIM AND OBJECTIVES

1.2.1AIM:

To compare the effects of ultrasound versus nerve and tendon gliding exercise on pain, self- reported symptom severity and functions in patients with carpal tunnel syndrome.

1.2.2 OBJECTIVES:

- To find out the effect of ultrasound on pain, in patients with carpal tunnel syndrome.
- To find out the effect of ultrasound on self- reported symptom severity in patients with carpal tunnel syndrome.
- To find out the effect of ultrasound on functional level in patients with carpal tunnel syndrome
- To find out the effect of nerve and tendon gliding on level of pain in patients with carpal tunnel syndrome.
- To find out the effect of nerve and tendon gliding on self- reported symptom severity in patients with carpal tunnel syndrome.
- To find out the effect of nerve and tendon gliding on functional level in patients with carpal tunnel syndrome.
- To compares the effect of ultrasound versus nerve and tendon gliding exercise on pain, self-reported symptom severity and functions in patients with carpal tunnel syndrome.

2. REVIEW OF LITERATURE

2.1CARPAL TUNNEL SYNDROME:

Gerritsen AA, de Krom MC, Struijs MA et al. Conducted a study, Conservative treatment options for carpal tunnel syndrome: a systematic review of randomized controlled trials and they stated that carpal tunnel syndrome (CTS), caused by compression of the median nerve at the wrist and is the most common entrapment neuropathy[13.]

Phalen, G.S., 1951, done a study spontaneous compression of median nerve at the wrist and he reported that Carpal tunnel syndrome (CTS) is the most common of all the nerve entrapment syndromes. It occurs due to squeezing of median nerve at wrist. He identified a provocative test to diagnose carpal tunnel syndrome[31.]

Levine, D.W., Simmons, B.P., Koris, M.J., et al., 1993 conducted a study, A self-administered Questionnaire for the assessment of severity of symptoms and functional Status in carpal tunnel syndrome, they Stated that CTS results in considerable discomfort and pain, limitation of activities of daily living, loss of sleep and work disability[24.]

2.2 PREVALENCE

Atroshi, I., et al., 1999 studied the prevalence of carpal tunnel syndrome in a general population. He identified that CTS is rather frequent in general population. Twenty percent of symptomatic subjects with symptoms of pain, numbness, and tingling in the hand, would be expected to have CTS based on clinical examination and electro physiological testing[2.]

2.3 ANATOMY

Primal Pictures. 2001. Primal 3D Interactive Series: Hand. Primal Pictures Ltd. Snell, R.S., 2000. Clinical Anatomy for Medical Students. Lippincott Williams & Wilkins, Baltimore, MD stated that, the carpus has a concave bony contour on its flexor surface and is covered by the flexor retinaculum. The bony carpus thus forms the floor and walls of the

carpal tunnel, with the rigid flexor retinaculum as its roof. The flexor retinaculum, or transverse carpal ligament, attaches to the tubercle of the scaphoid, the ridge of the trapezium and the ulnar aspect of the hook of the hamate and pisiform. The long flexors of the fingers and thumb pass through the carpal tunnel. The median nerve sits deep under the flex or retinaculum[33.]

Szabo, R.M.,et al 1994 reported a study median nerve displacement through the carpal canal and they reported that median nerve becomes superficial to the flexor digitorum superficialis muscle bellies just about 5 cm proximal to the transverse carpal ligament. They showed the difference between median nerve and digital flexor tendon excursion in carpal tunnel and the relationship between median nerve displacement and flexor tendons[38.]

2.4 ETIOLOGY:

Szabo, R.M., 1994 et al conducted a study, median nerve displacement through the carpal canal and concluded that the cause of compression of the median nerve at the carpal tunnel is the result of a discrepancy between the volume of the contents of the canal and its relative size. So it occurs due to compression or swelling of the median nerve in its synovial sheath[38.]

Gelberman et al., 1981; in his study carpal tunnel syndrome results of a prospective trial of steroid injection and splinting, he used a wick catheter to measure the intracarpal canal pressure in 15 individuals with carpal tunnel syndrome and 12 control subjects. The mean pressure in carpal canal was increased in carpal tunnel patients. And also the CT studies show a reduced cross sectional area of carpal canal in patients with carpal tunnel syndrome[12.]

2.5 DIAGNOSIS:

Szabo RM.et al, 1994 done a research, median nerve displacement through the carpal canal and reported that the physical examination for carpal tunnel syndrome may reveal findings related to reduced sensibility and reduced strength. Provocative tests like Phalen's, Tinle's and the tourniquet test will be used to diagnose carpal tunnel syndrome[38.]

Butleret.al in 1991, done a study, mobilization of the nervous system and stated that full examination with electrophysiological testing of cervical spine and wrist may be useful to identify double crush syndrome and he reported that failure to diagnose double crush syndrome will led to continuation of distal symptoms .He also stated that the other provocation tests like adverse neural tension tests**,** carpal compression tests also be used for diagnosis[9.]

Kimura, 1989; Kraft and Halvorson, et al 1983 conducted a study in patients with CTS and stated that, there are usually electrophysiological findings consistent with prolonged distal latency and delayed conductionvelocity of either the sensory or motor component of the median nerve or even of both components as compared to normative data or to uninvolved nerves on the same patient.

2.6 NERVE AND TENDON GLIDING:

Akalin, E., El, O., Peker, O., et al., 2002 conducted a study, Treatment of Carpal tunnel syndrome with nerve and tendon gliding exercise. In this study prospective, randomized, before-and-after treatment trial two groups (control and experimental) of patients are treated with splint for 4 weeks, and the experimental group alone received tendon and nerve gliding exercises. Evaluation with functional status scale and a symptom severity scale showed that the results in experimental group were better than control group; the difference was not statistically significant. And it was stated that further investigations are required to establish the role of nerve and tendon gliding exercises in the treatment of carpal tunnel syndrome[1.]

Rozmaryn, L.M., Dovelle, S., Rothman, E.R., et al., 1998, done a research on Nerve and tendon gliding exercises and the conservative management of carpal tunnel syndrome**.** In this study Rozmaryn treated 197 patients (240 hands) with CTS in two groups. Patients in both groups were treated by standard conservative methods, and those in one group were also treated with a program of nerve and tendon gliding exercises. Of those who did not perform the nerve and tendon gliding exercises, 71.2% underwent surgery compared with only 43.0% of patients who did perform them. Patients in the experimental group who did not undergo surgery were interviewed at an average follow-up time of 23 months. Of the 47 responders, 70.2% reported good or excellent results, 19.2% remained symptomatic, and 10.6% were non-compliant. The researchers concluded that a significant number of patients who would otherwise receive surgical intervention for failure of traditional conservative treatment can be spared the surgical morbidity of a carpal tunnel release[35.]

Muller M, Tsui D, Schnurr R, Biddulph-Deisroth L, Hard J, MacDermid JC.et.al., studied the Effectiveness of hand therapy interventions in primary management of carpal tunnel syndrome: a systematic review and concluded that a neural mobilization was more effective in relieving pain than no treatment[28.]

Goodyear-Smith F, Arroll B et.al, did a research, what can family physicians offer patients with carpal tunnel syndrome other than surgery- A systematic review of non-surgical management and said that there was possible benefit in reduced rates of surgery with the use of neural mobilization techniques[15.]

Totten, P.A., Hunter, J.M.,et al, 1991reported a study on, Therapeutic techniques to enhance nerve gliding in thoracic outlet syndrome and carpal tunnel syndrome ,they said nerve symptoms must be reduced when administering rehabilitation techniques. They also said patient is advised to use nerve gliding in a slow, controlled mannerand concluded that nerve and tendon gliding exercise will be effective in non-operative Carpal tunnel syndrome[40.]

Szabo RM, Bay BK, Sharkey NA.et.al., conducted a study, Median nerve displacement through the carpal canal and showed that the relationship between median nerve and flexor

tendon excursion was consistently linear. They said active finger motion of the median nerve and flexor tendons will prevent adhesion formation even if the wrist is immobilized[38.]

Seradge H, Jia Y, Owens W.et.al.,done a vivo measurement of carpal tunnel pressure in the functioning hand, demonstrated that intermittent active wrist and finger flexion-extension exercises will reduce the carpal tunnel pressure. It is possible to affect the course of CTS in some patients by using this exercise.

Rempel D, Manojlovic R, LevinsohnDG.et.al, studied the effect of wearing a flexible wrist splint on carpal tunnel pressure during repetitive hand activity and they reported that Tendon- and nerve-gliding exercises may maximize the relative excursion of the median nerve in the carpal tunnel and the excursion of flexor tendons relative to one another[34.]

2.7 ULTRASOUND

Oztas O, Turan B, Bora I et al., done a study on ultrasound therapy effect in carpal tunnel syndrome**.**They investigated the overall therapeutic effect of different intensities of repeated ultrasound application compared to placebo ultrasound on CTS. They found a slight increase in MDL and motor NCV at both intensities 1.5w/cm2 and 0.8w/cm2. But this difference was not more statistically significant than placebo ultrasound[30.]

Ebenbichler GR, Resch KL, Nicolacis P et al. Conducted a study on ultrasound treatment for treating the carpal tunnel syndrome: randomized 'sham' controlledtrial**.** They recently demonstrated that improvement was significantly more pronounced in actively treated than in sham treated wrists for both subjective symptoms and electro neuro graphical variables[10.]

Hong CZ, Lau HH and YU J et al in 1988 studied the ultrasound thermotherapy effect on the recovery of nerve conduction in experimental compression of neuropathy**.** They support the concept that ultrasound treatment might facilitate recovery from nerve compression[19.]

HAG et al and BINDER et al.,done a study in oral surgery**.**It is a single blind, controlled trial to assess the anti-inflammatory effects of dexamethasone and therapeutic ultrasound and reported that shown ultrasound could elicit anti-inflammatory and tissue stimulating effects[16.]

2.8 VISUAL ANALOGUE SCALE

Huskissonin et al done a study, pain measurement and assessment in 1983 and sriwatancula k, kelvie w et al., in 1983 in their studies with different types of Visual Analogue Scale for measurement of pain suggested the most common Visual Analogue Scale consists of 10 cm horizontal/vertical line with the two end points labeled "no pain" and " worst pain ever " [or similar verbal descriptors].The patient is required to place a mark on the 10cm line at a point which corresponds to the level of pain intensity he or she presently feels. The distance in centimeters from the low end of visual analogue scale to the patient's mark is used as a numerical index of the severity of pain. Huskisson also suggested that these simple methods have all been used effectively in hospital clinics and have provided valuable information about pain and analgesia[20.]

Belanger et al., in 1989 Conducted a study on pain of first –trimester abortion, a study of psychosocial and medical predictors pain suggested that Visual Analogue Scale is sensitive to pharmacological and non-pharmacological procedures which alter the experience of pain[6.]

Joyce et al., in 1975 done a study on comparison of fixed interval and visual analogue scales for rating chronic pain and suggested that Visual Analogue Scale has been described as superior because it was more sensitive than any other scale[21.]

Polly E.Bijur,ph.d.,et al., Conducted a study to assess the reliability of the visual analogue scale for measurement of acute pain by ICC (Intraclass correlation coefficients) and suggested that Visual Analogue Scale is sufficiently reliable to be used to assess the acute pain[32.]

McGrath PA et al, Conducted a study in 2005 and suggested that Visual analogue scale is the most common simple scale used in pain research. It is the most widely used scale in assessment of pain in clinical setting and has been reported to be sensitive and reliable.

2.9 DISABILITIES OF ARM, SHOULDER AND HAND SCORE

Michael warren Keith, M.D, Victoria Masear, Richard W.Barth.et.al, done a study Treatment of Carpal tunnel syndrome in 2009 and suggested that DASH will be used to assess patient responses to CTS for research[27.]

J R Greens lade, R L Mehta, P Belward, D J Warwick et al 2004 conducted a prospective study evaluates if the Disabilities of the Arm, Shoulder and Hand (DASH) questionnaire is an adequately responsive outcome measure To measure responsiveness (sensitivity to clinical change), 57 patients with a clinical diagnosis of carpal tunnel syndrome completed the DASH and BQ preoperatively and again 3 months after opencarpal tunnel decompression. A second group of 31 patients completed the questionnaires in the outpatient clinic and again 2 weeks later to assess test-retest reliability incarpaltunnel syndrome by comparing it with the disease-specific Boston questionnaire. This study concludes that the DASH questionnaire is a reliable, responsive and practical outcome instrument in carpal tunnel syndrome[22.]

A. Hoang-Kima, F. Pegreffib, A. Moronic, A Ladd et al 2010 assessed the quality of reviews published on patient oriented instruments in current use for assessing function of the hand and wrist joint. They highlight features of commonly used scales that improve readers' confidence in the choice and application of these outcome instruments. Recommendations of use and an overview are provided for the disability of the arm, shoulder and hand questionnaire (DASH), Quick DASH, the Michigan hand questionnaire (MHQ), the patient-rated wrist hand evaluation outcome questionnaire (PRWHE) and the carpal tunnel questionnaire (CTQ) scales with established measurement properties. The DASH, a region-specific 30-item questionnaire is the most widely tested instrument in

patients with wrist and hand injuries. The DASH has shown to be sufficiently responsive to outcome studies of carpal tunnel syndrome[18.]

2.10 HAND HELD DYNAMOMETER

Timothy Stark, BS, DC ,Bruce Walker, DC, MPH, Jacqueline K. Phillips, PhD, BVSc(Hons), René Fejer, BSc, MSc, PhD,Randy Beck et al., 2010 examined the current evidence regarding the reliability and validity of hand-held dynamometry for assessment of muscle strength. Considering hand-held dynamometry's ease of use, portability, cost, and compact size, compared with isokinetic devices this instrument can be regarded as a reliable and valid instrument for muscle strength assessment[39.]

3. MATERIALS AND METHODOLOGY

3.1 STUDY DESIGN:

Quasi -experimental study design.

3.2 STUDY POPULATION:

Patients with carpal tunnel syndrome

3.2.1 INCLUSION CRITERIA

- Mild to moderate CTS
- Right handed CTS
- Positive phalen's test
- Positive tinel's test
- Positive Carpal Compression test
- Positive nerve conduction study results
- Female subjects
- Age: 25 – 55 years

3.2.2 EXCLUSION CRITERIA

- Secondary entrapment neuropathies
- Peripheral neuropathy
- Double crush syndrome
- Pregnancy
- Thyroid disorder
- Distal radius fracture
- Demyelinating disorders
- Muscular disorders
- Skin disorders
- Peripheral vascular disorders

- Deformities of upper limb joint
- Connective tissue disorder
- Degenerative disorder of thumb
- Pronator teres syndrome

3.3 SAMPLE SIZE:

20 carpal tunnel syndrome patients.

- Group - A: 10 patients
- Group - B: 10 patients

3.4 SAMPLING TECHNIQUE:

Convenient sampling technique

3.5 STUDY SETTING:

Department of Physical Medicine and Rehabilitation,

Kovai Medical Centre and Hospital, Coimbatore.

3.6 NULL HYPOTHESIS

- There is no significant improvement with ultrasound on level of pain in patients with carpal tunnel syndrome.
- There is no significant improvement with ultrasound on self- reported symptom severity in patients with carpal tunnel syndrome.
- There is no significant improvement with ultrasound on level of functions in patients with carpal tunnel syndrome.
- There is no significant improvement with nerve and tendon gliding exercise on level of pain in patients with carpal tunnel syndrome.
- There is no significant improvement with nerve and tendon gliding on self- reported symptom severity in patients with carpal tunnel syndrome.

- There is no significant improvement with nerve and tendon gliding on level of functions in patients with carpal tunnel syndrome.
- There is no significant difference between ultrasound versus nerve and tendon gliding exercise on level of pain, self- reported symptom severity and level of functions in patients with carpal tunnel syndrome.

3.7 STUDY METHOD:

3.7.1 TREATMENT PROCEDURE:

The treatment was given for 3 weeks. 20 Patients who fulfils the inclusion criteria were assigned into two groups of 10 each. As group A received ultrasound and group B received nerve and tendon gliding exercises.

Pre-test scores using Visual analogue scale ,the disabilities of arm, shoulder and hand score and hand held dynamometer were taken prior to the treatment protocol post-test scores were taken after 3 weeks using the same.

3.7.2 PROTOCOL:

ULTRASOUND:

INTERVENTION: Ultrasound treatment is administered for 15 minutes per session to the area over the carpal tunnel at a frequency of 1MHZ and an intensity of 1.0W/CM^2 ,With pulsed mode duty cycle of 1:4 and a transducer area of 5cm^2,with aqua sonic gel as a couplant. A total of 15 ultrasound treatments were given once a day 5 times a week for 3 weeks.

FIGURE: 1

FIGURE: 2

NERVE AND TENDON GLIDING EXERCISES:

During tendon gliding exercises, the fingers were placed in five discrete positions. Those were (straight, hook, fist, table top, and straight fist). Each position kept for seven seconds.

FIGURE 3: STRAIGHT

FIGURE 4: HOOK

FIGURE 5: FIST

FIGURE 6: TABLE TOP

FIGURE 7: STRAIGHT FIST

During the median nerve gliding exercise, the median nerve was mobilized by putting the hand and wrist in six different positions. These exercise carried out with the patient in a sitting position that varied according to the patient's ability to relax the proximal musculature as a following:

Position 1: Exercises were begun with the wrist in a neutral position (0 degrees) and the fingers and thumb in the full flexion position. The distal median nerve was placed in a relatively relaxed position.

FIGURE 8:

Position 2: With the wrist kept in the neutral position, the fingers were brought to extension with the thumb in a neutral position. Tension in the distal segment of the nerves in the digits was increased.

FIGURE: 9

Position 3: With maintenance of finger extension and the neutral position of the thumb, wrist extension was added to the exercises. The area of greatest excursion was accessed as the wrist was extended.

FIGURE: 10

Position 4: While keeping the wrist and fingers extended, the thumb was extended. The median nerve branch to the thumb was included in this exercise.

FIGURE: 11

Position 5: With the wrist, fingers, and thumb kept in extension, the forearm was brought into supination. This added tension to the more proximal portion of the median nerve in the forearm.

FIGURE: 12

Position 6: With extension of the wrist, fingers, and thumb and supination of the forearm, slight tension was applied to the thumb with the other hand. During these exercises, the neck and the shoulder were in a neutral position, and the elbow was in supination and 90 degrees of flexion. Each position was maintained for 5 seconds. These exercises were applied 3 times a day. Each exercise was repeated 10 times the exercises program was continued for three weeks.

FIGURE: 13

3.8 OUTCOME MEASURES:

- Visual analogue scale: For quantifying pain.
- Disabilities of arm, shoulder and hand score: For assessing the severity of symptoms and functional impairments

3.8.1 MEASUREMENT TOOL:

Hand held dynamometer: For quantifying power grip.

3.9 STATISTICAL TEST:

Pre-test and post test values of the study will be collected and assessed for variation in improvement and their results will be analysed using independent "t" test and paired "t" test.

- **Paired 't' test:**

$$t = \frac{\bar{d}\sqrt{n}}{s}$$

$$\text{Where, } S = \sqrt{\frac{\Sigma d^2 - (\bar{d}^2)n}{n-1}}$$

- **Independent 't' test**

$$t = \frac{\overline{X_1} - \overline{X_2}}{s} \times \sqrt{\frac{n_1 n_2}{n_1 + n_2}}$$

$$s = \sqrt{\frac{\sum\left(x_1 - \bar{x}_1\right)^2 + \sum\left(x_2 - \bar{x}_2\right)^2}{n_1 + n_2 - 2}}$$

Where,

x_1 = values for Group A

x_2 = values for Group B

$\bar{X}_1$ = Average of Group A values

$\bar{X}_2$ = Average of Group B values x

n_1 = number of items in Group A

n_2 = number of items in Group B

S = standard deviation

4. DATA PRESENTATION

4.1 TABULAR PRESENTATION

PAIRED‘t’ TEST

Table: 4.1.1

GROUP-A: ULTRASOUND APPROACH

VISUAL ANALOGUE SCALE:

Scale	Mean value		Calculated ‘t’ Value	Table ‘t’ value	Level of significance
	Pre test	Post test			
Visual Analogue Scale	6.00	3.33	7.4286	2.262	0.05

Table: 4.1.2

GROUP-B: NERVE AND TENDON GLIDING EXERCISE

VISUAL ANALOGUE SCALE:

Scale	Mean value		Calculated ‘t’ Value	Table ‘t’ Value	Level of significance
	Pre test	Post test			
Visual Analogue Scale	5.90	4.30	6.0000	2.262	0.05

Table 4.1.3:

GROUP-A: ULTRASOUND APPROACH

THE DISABILITIES OF ARM, SHOULDER AND HAND SCORE

Scale	Mean value		Calculated 't' value	Table 't' value	Level of significance
	Pre test	Post test			
DASH	42.07	18.08	11.67	2.262	0.05

Table 4.1.4:

GROUP-B: NERVE AND TENDON GLIDINGEXERCISE

THE DISABILITIES OF ARM, SHOULDER AND HAND SCORE

Scale	Mean value		Calculated 't' Value	Table 't' Value	Level of Significance
	Pre test	Post test			
DASH	44.12	30.42	8.2410	2.262	0.05

Table 4.1.5:

GROUP-A: ULTRASOUND APPROACH

HAND HELD DYNAMOMETER

Scale	Mean value		Calculated 't' value	Table 't' value	Level of significance
	Pre test	Post test			
Hand held dynamometer	49.50	57.78	7.0711	2.262	0.05

Table4.1.6:

GROUP-B: NERVE AND TENDON GLIDINGEXERCISE

HAND HELD DYNAMOMETER

Scale	Mean value		Calculated 't' Value	Table 't' Value	Level of Significance
	Pre test	Post test			
Hand held dynamometer	47.00	53.33	4.4000	2.262	0.05

INDEPENDENT ‘t’ TEST:

Table 4.1.7:

PRE TEST VALUE OF GROUP A AND GROUP B

VISUAL ANALOGUE SCALE:

Scale	Mean value		Calculated ‘t’ Value	Table ‘t’ Value	Level of significance
	Group A	Group B			
Visual Analogue Scale	6.00	5.78	0.3171	2.101	0.05

Table 4.1.8:

POST TEST VALUE OF GROUP A AND GROUP B

VISUAL ANALOGUE SCALE:

Scale	Mean value		Calculated ‘t’ Value	Table ‘t’ Value	Level of significance
	Group A	Group B			
Visual Analogue Scale	3.20	4.22	2.2147	2.101	0.05

Table 4.1.9:

PRE TEST VALUE OF GROUP A AND GROUP B

THE DISABILITIES OF ARM, SHOULDER AND HAND SCORE

Scale	Mean value		Calculated 't' Value	Table 't' Value	Level of significance
	Group A	Group B			
DASH	42.07	43.63	0.4227	2.101	0.05

Table4.1.10:

POST TEST VALUE OF GROUP A AND GROUP B

THE DISABILITIES OF ARM, SHOULDER AND HAND SCORE

Scale	Mean value		Calculated 't' Value	Table 't' Value	Level of significance
	Group A	Group B			
DASH	18.35	29.61	4.814	2.101	0.05

Table4.1.11:

PRE TEST VALUE OF GROUP A AND GROUP B

HAND HELD DYNAMOMETER

Scale	Mean value		Calculated 't' Value	Table 't' Value	Level of significance
	Group A	Group B			
Hand held dynamometer	49.50	47.22	0.5145	2.101	0.05

Table4.1.12:

POST TEST VALUE OF GROUP A AND GROUP B

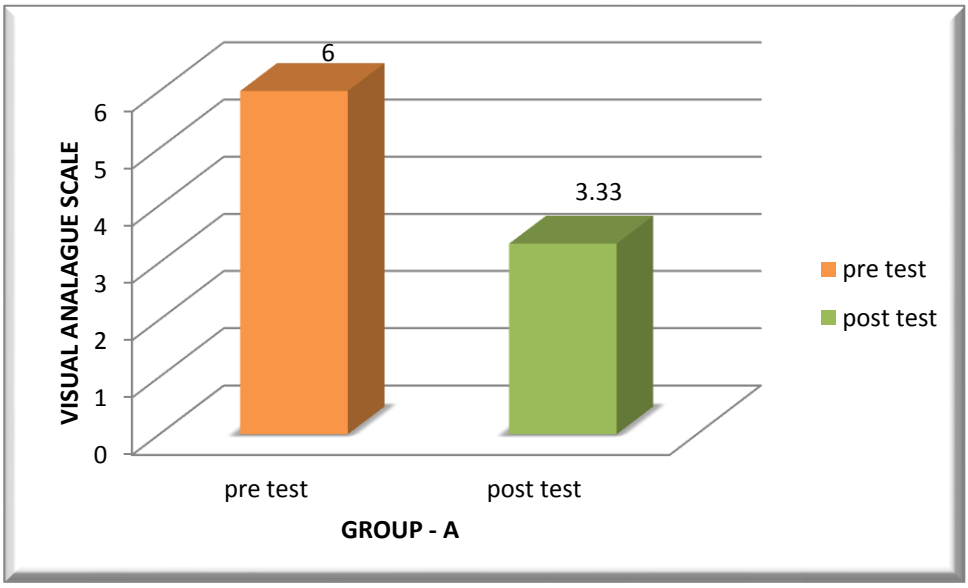
HAND HELD DYNAMOMETER

Scale	Mean value		Calculated 't' Value	Table 't' Value	Level of significance
	Group A	Group B			
Hand held dynamometer	58.50	53.33	1.4291	2.101	0.05

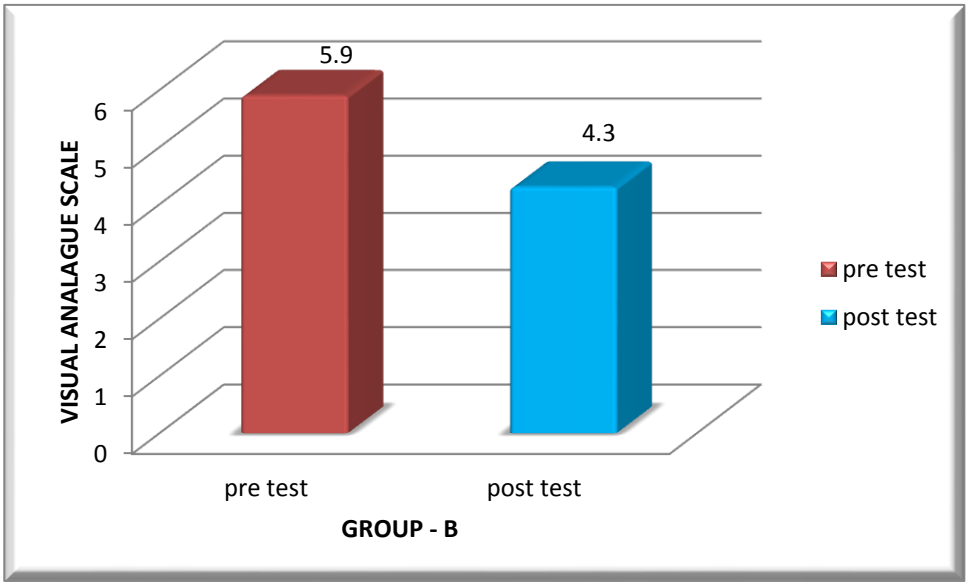
4.2 GRAPHICAL PRESENTATION

PAIRED 't' test

GRAPH 4.2.1: GROUP- A ,VISUAL ANALOGUE SCALE

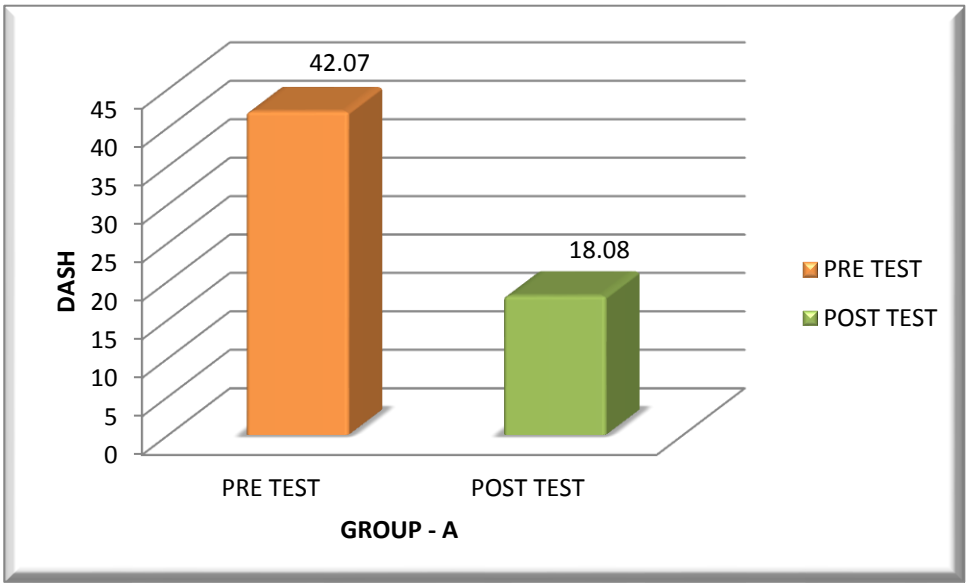


GRAPH 4.2.2: GROUP – B, VISUAL ANALOGUE SCALE



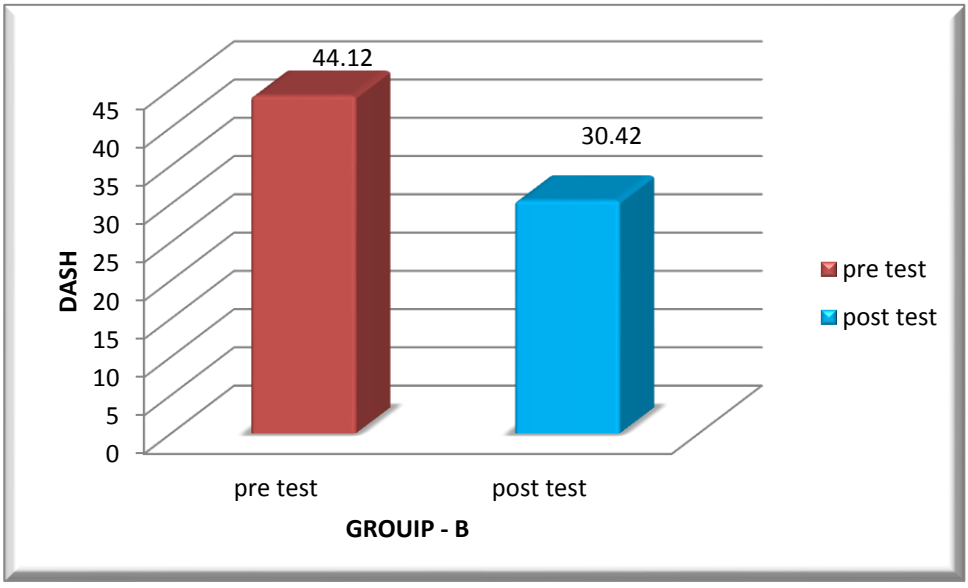
GRAPH 4.2.3: GROUP – A

THE DISABILITIES OF ARM, SHOULDER AND HAND SCORE



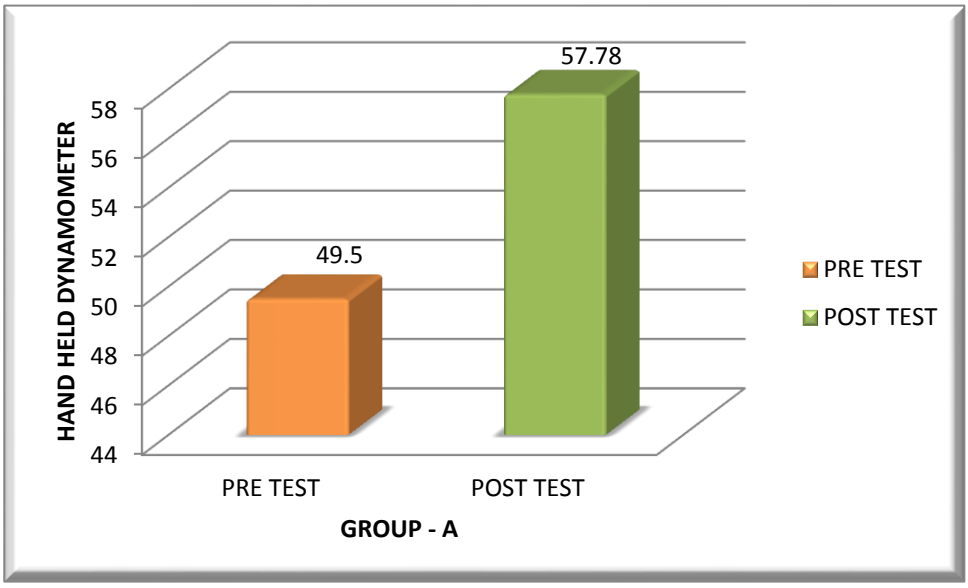
GRAPH 4.2.4: GROUP – B

THE DISABILITIES OF ARM, SHOULDER AND HAND SCORE



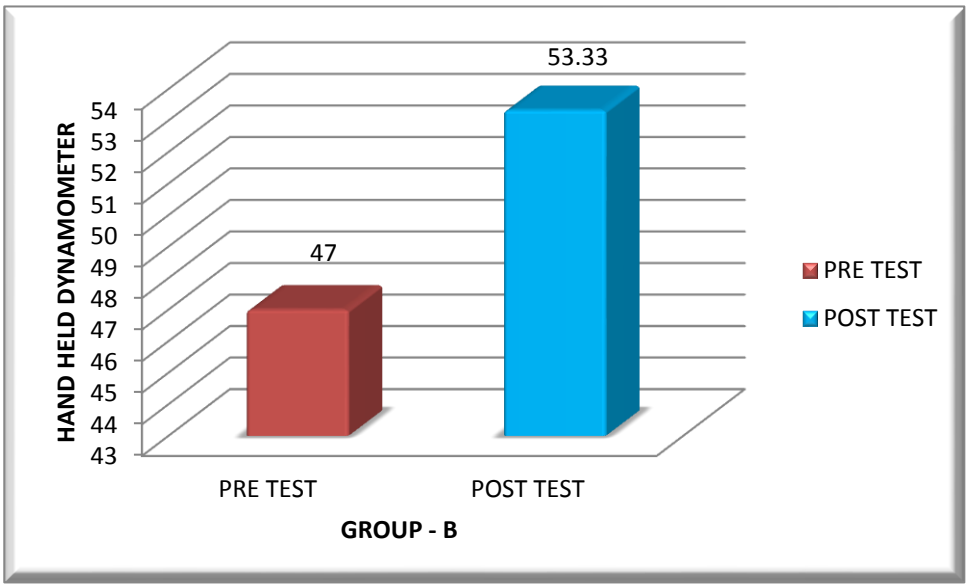
GRAPH 4.2.5: GROUP – A

HAND HELD DYNAMOMETER



GRAPH 4.2.6: GROUP – B

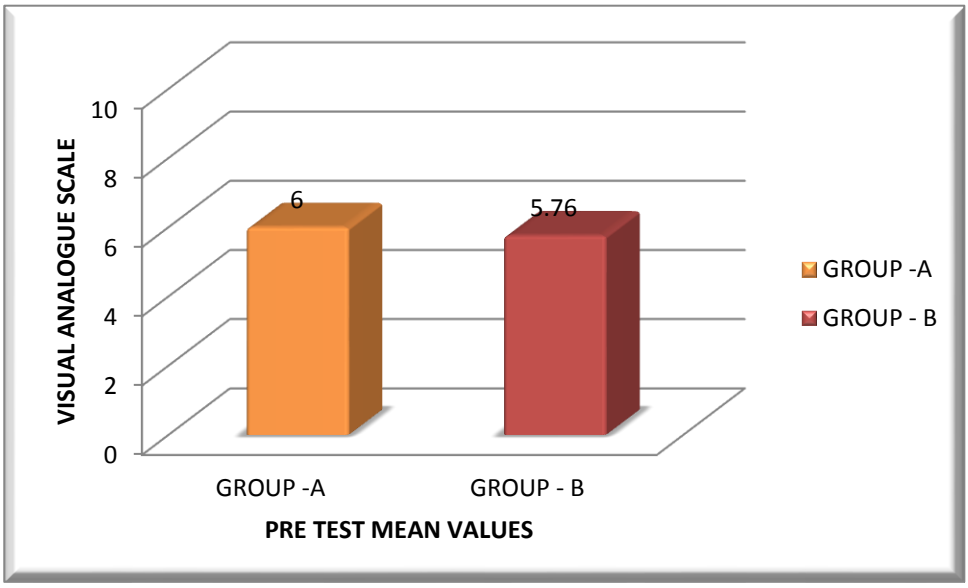
HAND HELD DYNAMOMETER



INDEPENDENT 't' TEST

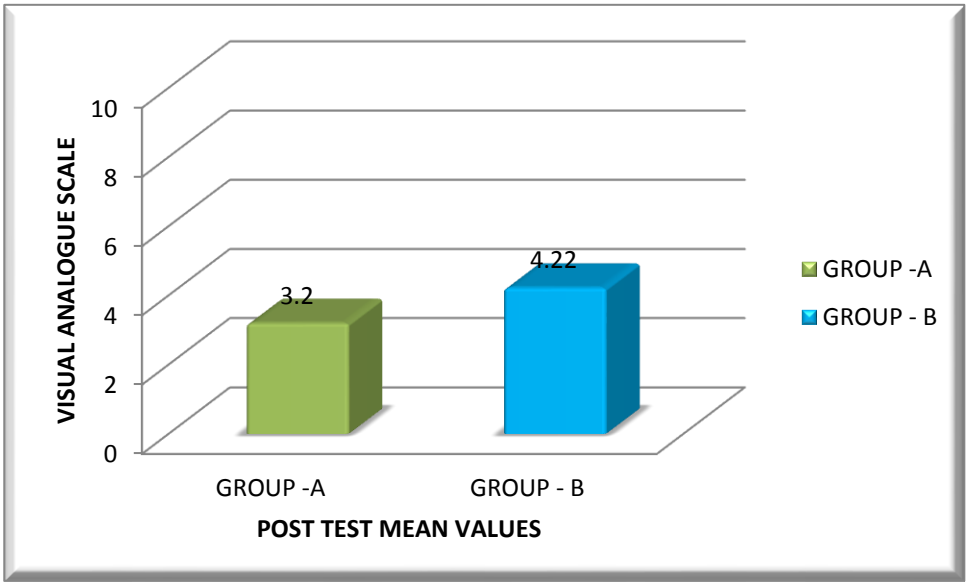
GRAPH 4.2.7: PRE TEST MEAN VALUES OF GROUP –A AND GROUP – B

VISUAL ANALOGUE SCALE

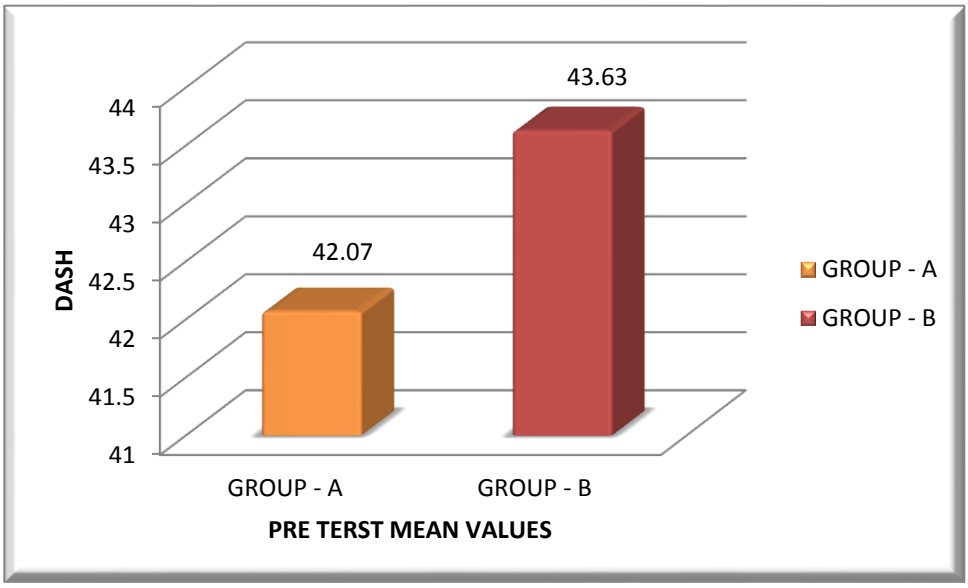


GRAPH 4.2.8: POST TEST MEAN VALUES OF GROUP –A AND GROUP – B

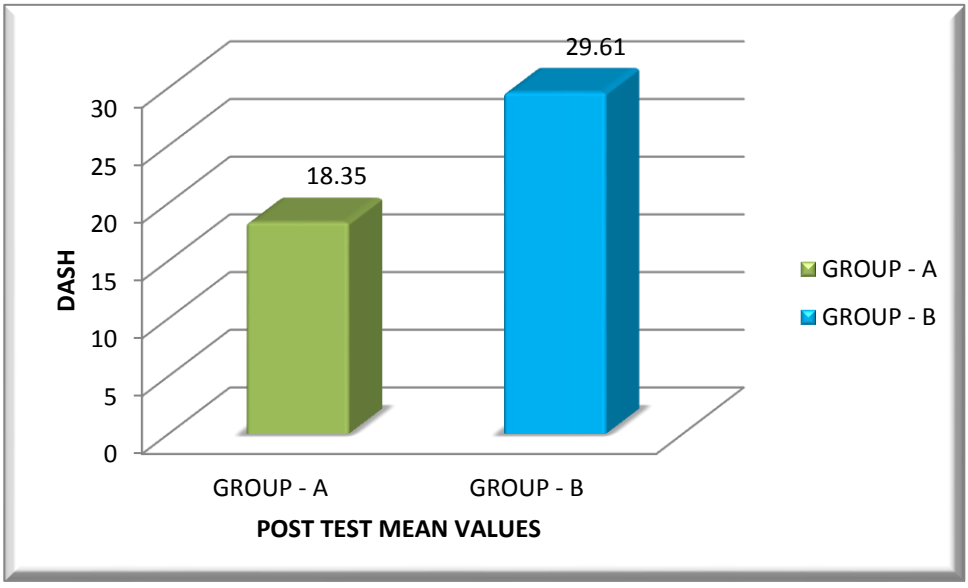
VISUAL ANALOGUE SCALE



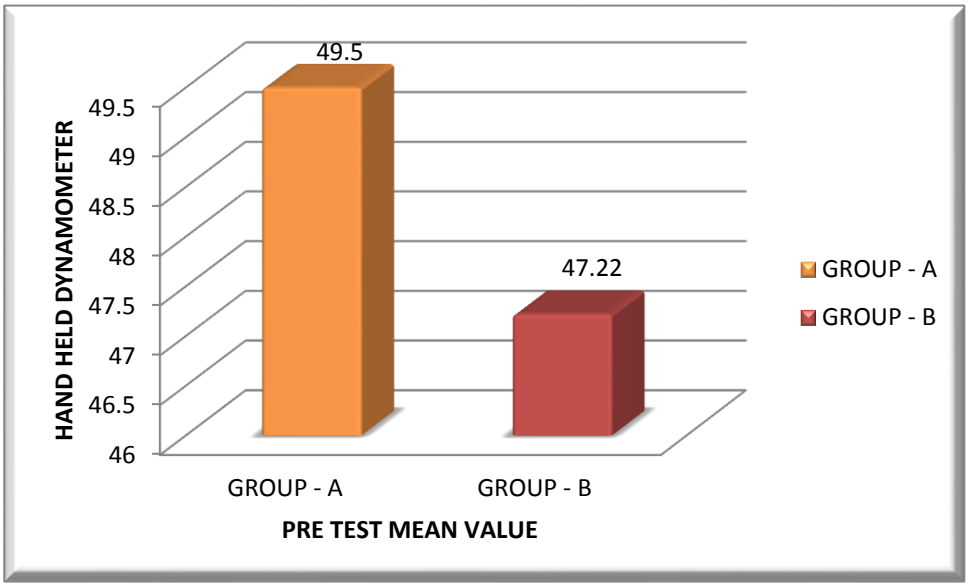
GRAPH 4.2.9: PRE TEST MEAN VALUES OF GROUP –A AND GROUP – B THE DISABILITIES OF ARM, SHOULDER AND HAND SCORE



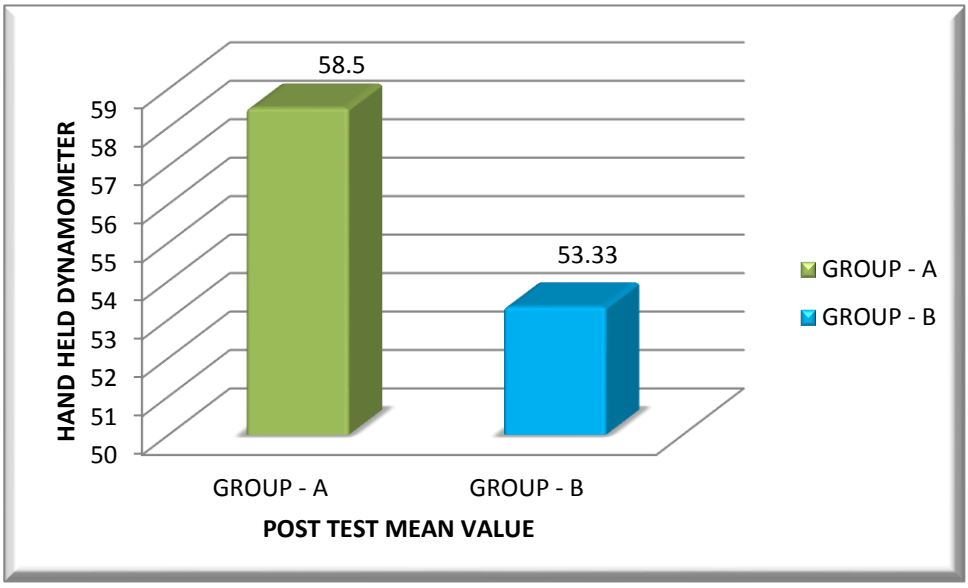
GRAPH 4.2.10: POST TEST MEAN VALUES OF GROUP –A AND GROUP – B THE DISABILITIES OF ARM, SHOULDER AND HAND SCORE



GRAPH 4.2.11: PRE TEST MEAN VALUES OF GROUP –A AND GROUP – B HAND HELD DYNAMOMETER



GRAPH 4.2.12: POST TEST MEAN VALUES OF GROUP –A AND GROUP – B HAND HELD DYNAMOMETER



5.DATA ANALYSIS AND INTERPRETATION

PAIRED‘t’ TEST VALUES FOR VISUAL ANALOGUE SCALE IN ULTRASOUND GROUP:

The- pre-test and post-test values of visual analogue scale were analyzed using paired ‘t’ test. For 9 degrees of freedom and at 5% level of significance, the table‘t’ value is 2.262 and the calculated ‘t’ value was 7.4286. As the calculated‘t’ value was greater than the table‘t’ value, null hypothesis was rejected. Hence there was significant effect of ultrasound in patients with CTS.

PAIRED‘t’ TEST VALUES FOR VISUAL ANALOGUE SCALE IN NERVE AND TENDON GLIDING EXERCISE GROUP:

The- pre-test and post-test values of visual analogue scale were analyzed using paired ‘t’ test. For 9 degrees of freedom and at 5% level of significance, the table‘t’ value is 2.262 and the calculated ‘t’ value was 6. As the calculated‘t’ value was greater than the table‘t’value, null hypothesis was rejected. Hence there was significant effect of nerve and tendon gliding exercise in patients with CTS.

PAIRED‘t’ TEST VALUES FORTHE DISABILITIES OF ARM, SHOULDER AND HAND SCOREINULTRASOUND GROUP:

The- pre-test and post-test values of the disabilities of arm, shoulder and hand score were analyzed using paired‘t’ test. For 9 degrees of freedom and at 5% level of significance, the table‘t’ value is 2.262 and the calculated ‘t’ value was 11.67. As the calculated‘t’ value was greater than the table ‘t’ value, null hypothesis was rejected. Hence there was significant effect of ultrasound in patients with CTS.

PAIRED‘t’ TEST VALUES FOR THE DISABILITIES OF ARM, SHOULDER AND HAND SCORE IN NERVE AND TENDON GLIDING EXERCISE GROUP:

The- pre-test and post-test values of the disabilities of arm, shoulder and hand score were analyzed using paired‘t’ test. For 9 degrees of freedom and at 5% level of significance, the table‘t’ value is 2.262 and the calculated ‘t’ value was 8.2410 . As the calculated‘t’ value was greater than the table ‘t’value, null hypothesis was rejected. Hence there was significant effectofnerve and tendon gliding exercise in patients with CTS.

PAIRED‘t’ TEST VALUES FOR HAND HELD DYNAMOMETER IN ULTRASOUND GROUP:

The- pre-test and post-test values of Hand held dynamometer were analyzed using paired ‘t’ test. For 9 degrees of freedom and at 5% level of significance, the table‘t’ value is 2.262 and the calculated ‘t’ value was 7.0711. As the calculated‘t’ value was greater than the table‘t’ value, null hypothesis was rejected. Hence there was significant effect of ultrasound in patients with CTS.

PAIRED‘t’ TEST VALUES FOR HAND HELD DYNAMOMETER IN NERVE AND TENDON GLIDING EXERCISE GROUP:

The- pre-test and post-test values of Hand held dynamometer were analyzed using paired ‘t’ test. For 9 degrees of freedom and at 5% level of significance, the table‘t’ value is 2.262 and the calculated ‘t’ value was 4.4000. As the calculated‘t’ value was greater than the table‘t’ value, null hypothesis was rejected. Hence there was significant effect of nerve and tendon gliding exercise in patients with CTS.

INDEPENDENT‘t’ TEST:

PRE-TEST VALUES OF VISUAL ANALOGUE SCALE FOR BOTH GROUP A and GROUP B:

The pre-test values of both the groups were analyzed using independent‘t’ test. For 18 degrees of freedom and 5% level of significance, the table‘t’ value 2.101 and the calculated ‘t’ value is0.3171. As the calculated‘t’ value was lesser than the table ‘t’ value, there was no significant difference between the pre-test values of both groups. Hence there was homogeneity between both groups before the experiment.

POST-TEST VALUES OF VISUAL ANALOGUE SCALE FOR BOTH GROUP A and GROUP B:

The post-test values of both the groups were analyzed using independent‘t’ test. For 18 degrees of freedom and 5% level of significance, the table‘t’ value 2.101 and the calculated ‘t’ value is2.2147. As the calculated‘t’ value was greater than the table‘t’ value, null hypothesis rejected. Hence there was significant difference found between both the groups.

PRE-TEST VALUES OFTHE DISABILITIES OF ARM, SHOULDER AND HAND SCORE FOR BOTH GROUP A and GROUP B:

The pre-test values of both the groups were analyzed using independent‘t’ test. For 18 degrees of freedom and 5% level of significance, the table‘t’ value 2.101 and the calculated ‘t’ value is 0.4227. As the calculated‘t’ value was lesser than the table‘t’ value, there was no significant difference between the pre-test values of both groups. Hence there was homogeneity between both groups before the experiment.

POST-TEST VALUES OF THE DISABILITIES OF ARM, SHOULDER AND HAND SCOREFOR BOTH GROUP A and B:

The post-test values of both the groups were analyzed using independent‘t’ test. For 18 degrees of freedom and 5% level of significance, the table‘t’ value 2.101 and the calculated ‘t’ value is 4.814. As the calculated‘t’ value was greater than the table‘t’ value, null hypothesis rejected. Hence there was significant difference found between both the groups.

PRE-TEST VALUES OF HAND HELD DYNAMOMETER FOR BOTH GROUP A and B:

The pre-test values of both the groups were analyzed using independent‘t’ test. For 18 degrees of freedom and 5% level of significance, the table‘t’ value 2.101 and the calculated ‘t’ value is 0.5145 . As the calculated‘t’ value was lesser than the table‘t’ value, there was no significant difference between the pre-test values of both groups. Hence there was homogeneity between both groups before the experiment.

POST-TEST VALUESOF HAND HELD DYNAMOMETER FOR BOTH GROUP A and B:

The post-test values of both the groups were analyzed using independent‘t’ test. For 18 degrees of freedom and 5% level of significance, the table‘t’ value 2.101 and the calculated ‘t’ value is 1.4291. As the calculated‘t’value was lesser than the table‘t’ value null hypothesis is accepted. Hence there was no significant difference found between both the groups.

6.DISCUSSION

There are numerous symptoms present in Carpal tunnel syndrome. The symptoms are mostly due to compression of median nerve. Patients usually complaints of pain and sensory disturbance.The treatment choice in carpal tunnel syndrome is still controversial.Many studies concluded that conservative treatment will be the effective treatment.[23, 17, and 42]

The current study was conducted to compare the efficacy of ultrasound versus nerve and tendon gliding exercise. In carpal tunnel syndrome various studies reported the conservative management for mild to moderate carpal tunnel syndrome[4]. One study reported ultrasound may facilitate recovery from carpal tunnel syndrome[11, 25].Nerve and tendon gliding exercise may also useful to patients who considered for surgery. But high level evidence is not available. In our study the female subjects of age 25-55 years were taken and most of them are house wives and clerks doing typing works because the hand intensive nature of house hold activities and typing may lead to higher incidence of carpal tunnel syndrome in women.

Based on the findings of this study, there was significant difference in the mean values of pain, self -reported symptom severity and power grip strength within groups after treatment in ultrasound group. Therefore the dosage and treatment time used in this study may be sufficient to provide continuous energy to accelerate repair, and to decrease the inflammatory response.

The nerve and tendon gliding exercise used in this study also result in significant difference in the mean values of pain, self -reported symptom severity and power grip strength within groups after treatment. These techniques will improve the excursion of nerve, reducing adhesions, improve oxygenation to nerve, and decrease pain.

But comparing both groups the ultrasound group showed significant improvement in pain and self -reported symptom severity than nerve and tendon gliding group. In hand

held dynamometer there is no significant difference between these two groups but according to the mean values of both groups the ultrasound will be effective in improving the grip strength also.Becausethe Visual analogue scale and the disabilities of arm, shoulder and hand score scale is patient'sself-reporting scales and hand held dynamometer is testing the strength of power grip is a practical measurement tool. It shows the pain and functional activities in ultrasound group got improvement due to increase in blood flow, local metabolism, tissue regeneration and reducing inflammation there by it gives recovery from nerve compression.

In Carpal tunnel syndrome, muscle atrophy is also present in some cases. This might be the reason why both groups don't show significant improvements in muscle power when tested by hand held dynamometer. Also one more possible cause may be due to the reason that in this study no interventions were given to increase the muscle power. May be in future studies additional of exercises can also be incorporated.

Nerve and tendon gliding exercise may be effective if applied to a specific subpopulation of carpal tunnel syndrome. It is possible that nerve and tendon gliding may be more effective in a population with less advanced carpal tunnel syndrome. Identifying the specific pathogenesis of carpal tunnel syndrome may be important in determining the true efficacy of neural gliding exercises. Carpal tunnel syndrome caused by ischemia may be positively affected by treatment with nerve and tendongliding exercises.

Nerves are sensitive to prolonged ischemic states due to the highdemand of circulating oxygen. The mechanism by which nerve and tendon gliding exercises relieve pain is by contributing to the delivery of oxygenated blood to the median nerve at itsdistal site within the wrist and hand.There is also evidence that median nerve excursion can be influenced by neural gliding techniques, as demonstrated in a cadaveric study. The results of these studies lend credibility to the use of movement-based interventions such as nerve and tendon gliding techniques for carpal tunnel exercises. It is possible that nerve and tendon gliding exercises may also benefit patients with mechanical compression of the median nerve.

The reason why ultrasound group shown superior improvement than nerve and tendon gliding exercise is that it is more of a passive treatment in which there is no attention required by the patient. And also it has its effect on cellular level that limits the inflammatory response. In contrast nerve and tendon gliding exercise are needed to be actively done by the patient. The patient ability to learn the correct technique also plays an important role and sometimes due to pain they may limit short of the end range stretch which cannot be supervised at all times.

7. LIMITATIONS AND SUGGESTIONS

7.1 LIMITATIONS:

- Sample size was small
- Treatment duration was very short
- Exercises was not given to improve the hand grip strength
- Only female patients were taken

7.2 SUGGESTIONS:

- Larger population can be included in the study.
- More outcome measures can be used to confirm the improvement.
- Longer duration study can to be conducted.

8. CONCLUSION

The aim of this study was to compare the effect of ultrasound versus nerve and tendon gliding exercise on pain and functions in patients with carpal tunnel syndrome. Twenty carpal tunnel patients were recruited to the study by convenient sampling technique. Ten patients were assigned to Group – A and Ten patients were assigned to Group – B. The intervention duration was about 3 weeks. Visual analogue scale, the disabilities of the arm, shoulder and hand score and hand held dynamometer were used as the outcome measures. Statistical analysis was done using the‘t’ tests. The results generated from the collected data shown that there is significant improvement in Group -A for Visual analogue scale and the disabilities of arm, shoulder and hand score than Group - B. But there is no significant improvement for hand held dynamometer in both groups.

The findings of this study suggest that ultrasound improves the pain and functions than nerve and tendon gliding exercise in patients with Carpal tunnel syndrome .Future studies with various outcome measures, larger group and longer duration are required to confirm the results.

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APPENDIX I

INFORMED CONSENT FOR PARTICIPATION IN RESEARCH STUDY

PATIENT INFORMATION FORM

TITLE OF THE STUDY:*THE EFFECT OF ULTRASOUND VERSUS NERVE AND TENDON GLIDING EXERCISE ON PAIN AND FUNCTIONS IN PATIENTS WITH CARPAL TUNNEL SYNDROME*

PURPOSE OF THE STUDY:

You _____ is being invited to take part in a study where I am comparing ultrasound versus nerve and tendon gliding in carpal tunnel syndrome patients.

STUDY PROCEDURE:

Duration of the treatment: 3 weeks. In the first day, you _____ will be evaluated by the outcome measure. After evaluation one group will be treated using ultrasound and other group will be treated using nerve and tendon gliding exercise. Then comparing the effects of intervention within the group and between the groups to be done finally.

BENEFITS OF PARTICIPATION IN THE STUDY:

You _____ may have likely benefits of improvement in pain and functional performance by taking part in the study. Other patients may also benefit in the future from what is learned from this study.

POSSIBLE RISKS AND DISCOMFORTS:

There are no possible risks or discomforts to be experienced by you during this study.

CONFIDENTIALITY:

The data collected during study will be used without revealing your identity. Your _____ identity will be confidential even if the results of the study are published.

WITHDRAWL:

If you decide to withdraw from the study, you are free to do it at any time.

INFORMED CONSENT FORM

STATEMENT OF THE PARTICIPANTS:

I……have been explained in detail about the procedures to be carried out in the study.

I have been given opportunity to discuss and ask questions with the responsible Physiotherapist regarding the study.

I have understood that no harm to my _____ health by participating in this study.

I agree for my Consultant (orthopedic surgeon) to be notified that I am taking part in the above study.

I agree to participate voluntarily in the study described in this form.

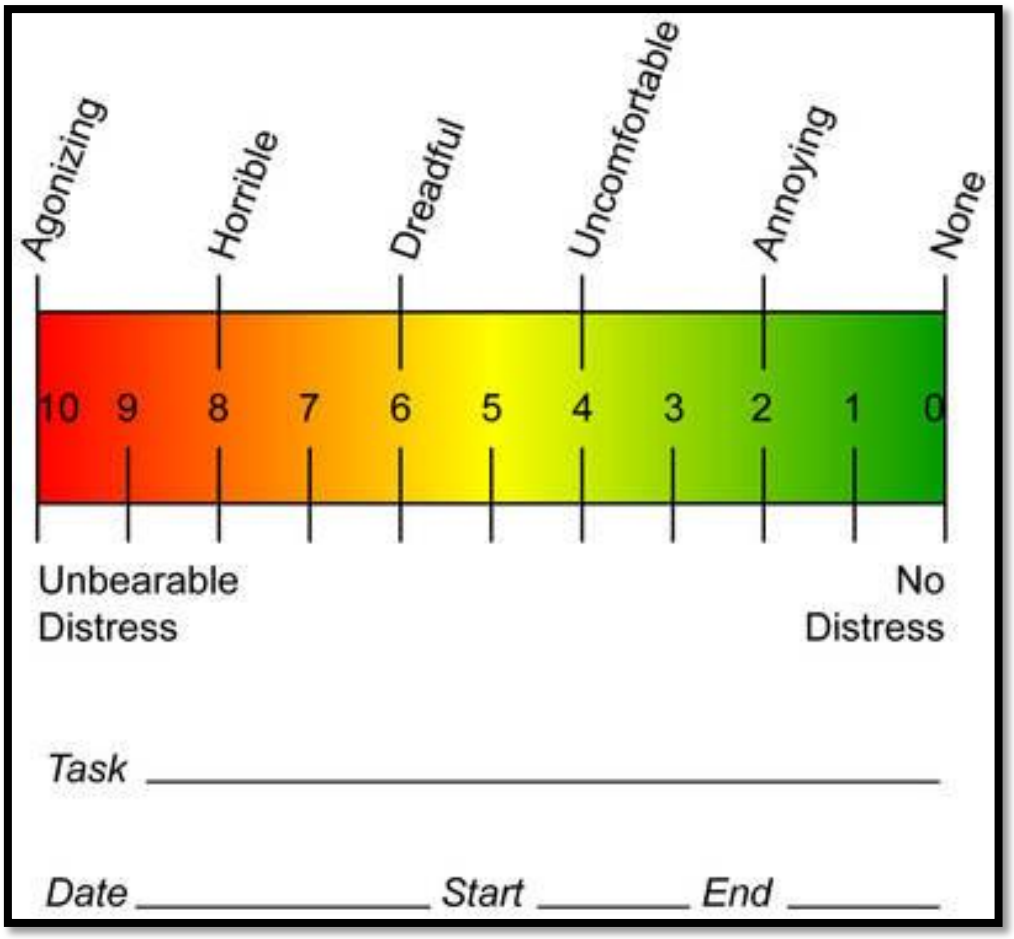
Name of Subject Signature Date

Name of Investigator Signature Date

Name of Witness Signature Date

APPENDIX II

VISUAL ANALOGUE SCALE



APPENDIX III

The Disabilities of the Arm, Shoulder and Hand (DASH) Score

Clinician's name (or ref) _____ **Patient's name (or ref** _____

INSTRUCTIONS: This questionnaire asks about your symptoms as well as your ability to perform certain activities. Please answer *every question* , based on your condition in the **last week**. If you did not have the opportunity to perform an activity in the past week, please make your *best estimate* on which response would be the most accurate. It doesn't matter which hand or arm you use to perform the activity; please answer based on you ability regardless of how you perform the task.

Please rate your ability to do the following activities in the last week.

1. Open a tight or new jar	No difficulty	Mild difficulty	Moderate difficulty	Severe difficulty	Unable
2. Write	No difficulty	Mild difficulty	Moderate difficulty	Severe difficulty	Unable
3. Turn a key	No difficulty	Mild difficulty	Moderate difficulty	Severe difficulty	Unable
4. Prepare a meal	No difficulty	Mild difficulty	Moderate difficulty	Severe difficulty	Unable
5. Push open a heavy door	No difficulty	Mild difficulty	Moderate difficulty	Severe difficulty	Unable
6. Place an object on a shelf above your head	No difficulty	Mild difficulty	Moderate difficulty	Severe difficulty	Unable
7. Do heavy household chores (eg wash walls, wash floors)	No difficulty	Mild difficulty	Moderate difficulty	Severe difficulty	Unable
8. Garden or do yard work	No difficulty	Mild difficulty	Moderate difficulty	Severe difficulty	Unable
9. Make a bed	No difficulty	Mild difficulty	Moderate difficulty	Severe difficulty	Unable
10. Carry a shopping bag or briefcase	No difficulty	Mild difficulty	Moderate difficulty	Severe difficulty	Unable
11. Carry a heavy object (over 10 lbs)	No difficulty	Mild difficulty	Moderate difficulty	Severe difficulty	Unable
12. Change a lightbulb overhead	No difficulty	Mild difficulty	Moderate difficulty	Severe difficulty	Unable
13. Wash or blow dry your hair	No difficulty	Mild difficulty	Moderate difficulty	Severe difficulty	Unable
14. Wash your back	No difficulty	Mild difficulty	Moderate difficulty	Severe difficulty	Unable
15. Put on a pullover sweater	No difficulty	Mild difficulty	Moderate difficulty	Severe difficulty	Unable
16. Use a knife to cut food	No difficulty	Mild difficulty	Moderate difficulty	Severe difficulty	Unable
17. Recreational activities which require little effort (egcardplaying, knitting, etc)	No difficulty	Mild difficulty	Moderate difficulty	Severe difficulty	Unable
18. Recreational activities in which you take some force or impact through your arm, shoulder or	No difficulty	Mild difficulty	Moderate difficulty	Severe difficulty	Unable

	hand (eg golf, hammering, tennis, etc)									
19.	Recreational activities in which you move your arm freely (eg playing frisbee, badminton, etc)	○	**No difficulty**	○	**Mild difficulty**	○	**Moderate difficulty**	○	**Severe difficulty**	○ **Unable**
20.	Manage transportation needs (getting from one place to another)	○	**No difficulty**	○	**Mild difficulty**	○	**Moderate difficulty**	○	**Severe difficulty**	○ **Unable**
21.	Sexual activities	○	**No difficulty**	○	**Mild difficulty**	○	**Moderate difficulty**	○	**Severe difficulty**	○ **Unable**
22.	During the past week, *to what extent* has your arm, shoulder or hand problem interfered with your normal social activities with family, friends, neighbours or groups?	○	**Not at all**	○	**Slightly**	○	**Moderately**	○	**Quite a bit**	○ **Extremely**
23.	During the past week, were you limited in your work or other regular daily activities as a result of your arm, shoulder or hand problem?	○	**Not limited at all**	○	**Slightly limited**	○	**Moderately limited**	○	**Very limited**	○ **Unable**
	Please rate the severity of the following symptoms in the last week									
24.	Arm, shoulder or hand pain	○	**None**	○	**Mild**	○	**Moderate**	○	**Severe**	○ **Extreme**
25.	Arm, shoulder or hand pain when you performed any specific activity	○	**None**	○	**Mild**	○	**Moderate**	○	**Severe**	○ **Extreme**
26.	Tingling (pins and needles) in your arm, shoulder or hand	○	**None**	○	**Mild**	○	**Moderate**	○	**Severe**	○ **Extreme**
27.	Weakness in your arm, shoulder or hand	○	**None**	○	**Mild**	○	**Moderate**	○	**Severe**	○ **Extreme**
28.	Stiffness in your arm, shoulder or hand	○	**None**	○	**Mild**	○	**Moderate**	○	**Severe**	○ **Extreme**
29.	During the past week, how much difficulty have you had sleeping because of the pain in your arm, shoulder or hand?	○	**No difficulty**	○	**Mild difficulty**	○	**Moderate difficulty**	○	**Severe difficulty**	○ **So much I can't sleep**
30.	I feel less capable, less confident or less useful because of my arm, shoulder or hand problem	○	**Strongly disagree**	○	**Disagree**	○	**Neither agree nor disagree**	○	**Agree**	○ **Strongly agree**

APPENDIX IV

ASSESSMENT FORM

- Name:
- Age :
- Gender :
- Occupation:
- OP Number :
- Side of involvement:
- Date of assessment :
- Vital signs :
- Nerve conduction results:

VISUAL ANALOGUE SCALE

- Pre- test …….
- Post- test …….

THE DISABILITIES OF ARM, SHOULDER AND HAND SCORE

- Pre -test …….
- Post -test …….

HAND HELD DYNAMOMETER

- Pre -test …….
- Post- test …….